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Procurement in Infrastructure

What Does Theory Tell Us?

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Abstract

Infrastructure has particular challenges in public procurement, because it is highly complex and customized and often requires economic, political and social considerations from a long time horizon. To deliver public infrastructure services to citizens or taxpayers, there are a series of decisions that governments have to make. The paper provides a minimum package of important economic theories that could guide governments to wise decision-making at each stage. Theory suggests that in general it would be a good option to contract out infrastructure to the private sector under high-powered incentive mechanisms, such as fixed-price contracts. However, this holds under certain conditions. Theory also shows that ownership should be aligned with the ultimate responsibility for or objective of infrastructure provision. Public and private ownership have different advantages and can deal with different problems. It is also shown that it would be a better option to integrate more than one public task (for example, investment and operation) into the same ownership, whether public or private, if they exhibit positive externalities.

This paper—a product of the Economics Team, Finance Economics & Urban Department—is part of a larger effort in the department to deepen our understanding of public infrastructure procurement from the theoretical point of view and thereby contribute to enhancing its effectiveness in operations. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at aiimi@worldbank.org.

PROCUREMENT IN INFRASTRUCTURE: WHAT DOES THEORY TELL US?[¶]

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I. INTRODUCTION

Infrastructure poses challenges that are not found in other areas of public procurement. The fundamental reason is that infrastructure is a highly complex and customized object and therefore, not only economic but also political, social and environmental considerations would be required from a long time horizon. In order to deliver public infrastructure services to citizens or taxpayers, there are a series of decisions that governments have to make. At each stage, there are several important economic theories that could guide government decision-making. This paper aims to provide a minimum package of theoretical propositions to answer such policy questions by reviewing representative contributions. Having said that, some important features in reality, such as political and institutional conditions, may not be taken into account in order to focus on theoretical discussion. Also, this is not a survey; there are of course many other theoretical developments beyond the paper.[1] But the paper focuses on practicability and simplicity through interpreting theoretical models intuitively, rather than restating formal proofs. For further details, including theoretical assumptions and conclusions, see the cited original papers.

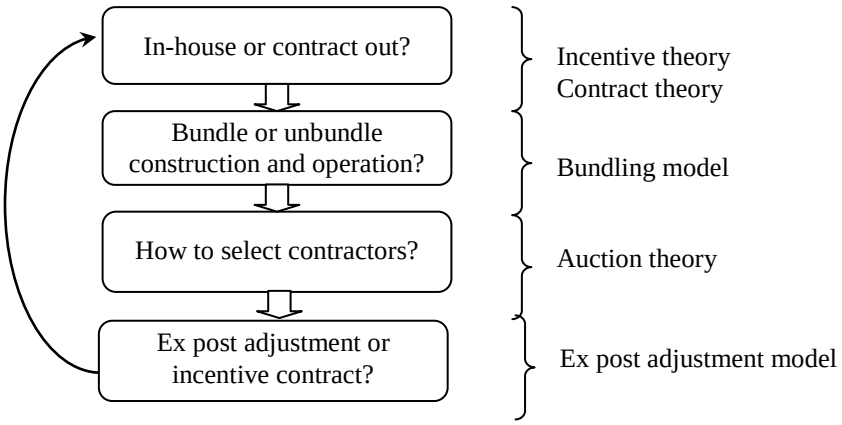
A sequence of governmental decisions on infrastructure procurement may be fourfold, as shown in Figure 1. First, governments must decide whether to produce infrastructure goods and services in-house or procure them from the outside, which refers to any entity other than government employees. This is a traditional question of public economics. The primary question is: Under what conditions should governments choose the option of contracting-out? This can be addressed by traditional incentive theory and incomplete contract theory developed since Hart (1995; 2003) and Hart *et al*. (1997).

Second, once governments decide to procure goods and services from the outside, the next question is how to align authorities and responsibilities with stakeholders. There are different stakeholders that can carry out some pieces of discrete tasks, including ownership. Who

[1] For comprehensive studies, see Dimitri *et al*. (2006) and Janssen (2004).

should own infrastructure? Who should operate? Who should invest in public assets? Under what circumstances could those tasks be delegated to different agents? What circumstances call for bundling them together under a single agent? The theoretical approach that views public procurement as a problem of bundling and unbundling multiple distinct tasks could reply to these questions (e.g., Hart, 2003; Bennett and Iossa, 2005). While bundling everything under state ownership means nationalization of infrastructure, unbundling some of the tasks can represent some forms of private sector participation in infrastructure, as in public private partnerships (PPP).[2]

Figure 1. Government decisions and theoretical models



Third, when the scope of public tasks being delegated to outside contractors is determined, governments need to make a decision on how to select the best private partner. This is addressed largely by auction theory, which is normally discussed under the totally different setting from (incomplete) contract theory. The selection of agents or contractors raises a series of questions. How should auctioneers design the award mechanism for efficiency purposes? What mechanisms are available to assess potential venders, operators and contractors? How could governments prevent and detect collusion and corruption? Is there any optimal level of competition in public tendering? How could governments encourage

[2] The economic literature on public procurement has made tremendous progress in recent decades. See, for example, the comprehensive study of Laffont and Tirole (1993). On public–private partnerships, see Harris (2003) for an account of recent trends in developing countries. Also see IMF (2004).

more bidder participation to achieve auction efficiency? There are a number of theoretical propositions in this area. The current paper selectively discusses some of them.

Finally, after the commencement of a contract, there is a high likelihood or risk that either contractor or government would seek for ex post adjustment of the contract for some reason. There are potentially a number of unforeseeable and thus non-contractible issues in public procurement, especially in long-term complex infrastructure projects. A certain number of studies have discussed the relationship between ex ante contracting and ex post adjustment (e.g., Bajari and Tedelis, 2001; Guasch *et al.*, 2007, 2008). Notably, if flexible contractual arrangements are preferred rather than strong incentive contracts, the government decision making may return to the first question on whether to contract out public infrastructure to the private sector because it implies some difficulties in contracting out. This is not surprising because a series of government decisions are normally dynamic and evolutionary.

Procurement in infrastructure has gathered renewed momentum because of the recent upsurge and following slowdown of private sector participation in infrastructure as well as the reemergence of the state role in infrastructure development. In tandem, the economic literature continues providing a number of insightful propositions. The remaining sections are organized as follows. Section II discusses the first question of whether to produce public work in-house or contract it out to outsiders. Section III examines who should take the responsibility for what. In Section IV some of the important propositions from auction theory are reviewed in the context of infrastructure procurement. Section V provides some important foundations from theories on ex post adjustments or renegotiation.

II. IN-HOUSE OR CONTRACTING OUT?

Traditional economic theory has characterized procurement as a principal-agent relationship where the government, as a benevolent principal, intends to accomplish a piece of public work that cannot be performed by itself and therefore delegate the task to an agent, which

could be either a government employee or a private company. A seminal contribution by Laffont and Tirole (1993) provides a comprehensive view of the incentive problem in public procurement. The main source of difficulty in the principal-agent model is that the government cannot observe some critical information of its agent, such as agent's made efforts and its trustworthiness, namely *type*, which can also be interpreted as its owned intrinsic technology (i.e., efficient or inefficient agent). If the government knew the agent's type or could observe the effort made by the agent, it could simply negotiate directly with each agent and mandate the optimal level of effort given each known type. In reality, however, the government often lacks the information of who are the efficient agents, how much effort they made and to what extent the performance would be attributable to their efforts (i.e., asymmetric information problem). Even though the government can observe the agent's type or effort, it may not be verifiable because of judicial or customary flaws.

Therefore, a matter of concern in public procurement emerges as a problem of incentives. The government cannot monitor the agent's effort toward cost cutting and may not be able to induce its agent to make the maximum of effort to contain public procurement costs (i.e., moral hazard or hidden action problem). The government may also be faced with an adverse selection or hidden knowledge problem, because it has less information about the technology than the agent. It is noteworthy that in incentive theory, the cost of producing or delivering a public work is assumed to be observable, contractible and enforceable. In other words, even though the agent's true cost can be observed, it does not solve an entanglement of the hidden types and unobservable efforts.

The incentive theory highlights a basic trade-off between cost reduction and rent extraction. A positive rent is needed to withdraw the efficient level of effort from the efficient agent, while no rent has to be left for the inefficient agent. When comparing bipolar contractual forms that are common in public procurement, fixed-price and cost-plus contracts, the conclusion may suggest the relative importance of the former, because the fixed payment arrangement entitles the agent to retain a potential savings or rent generated by its effort

toward cost cutting.[3] Under cost-plus contracts, on the other hand, the agent cannot exploit any savings regardless of realized cost reductions, leaving little incentive to make an effort.

Proposition 1. Under the principal-agent relationship, fixed-price contracts are more consistent with the optimal incentive package that could induce efficient contractors to make the maximum effort to cost reductions in public works.

A shortcoming of traditional incentive theory, however, is that contracts are assumed complete. If a contract were complete and could account for all conceivable contingencies, ownership would not matter, because the government could control every aspect of the relationship through the contract and achieve the efficient outcome regardless of ownership structure. In reality, complex public works, such as infrastructure development projects, often violate this assumption. When contracts are incomplete, it is ownership that determines who has the right to control unforeseen events that would happen. One of the earliest studies casting light on contractual incompleteness is Simon (1951), in which the implicit employment relationship is analyzed.

The property rights literature explains the role of asset ownership in the principal-agent relationship for general public contracts (e.g., Grossman and Hart, 1986; Hart and Moore, 1990; Hart, 1995; Whinston 2003). It does not assume completeness of contracts but maintains the assumption that two parties involved (i.e., a procuring government and a contractor) are locked in the contractual relationship. The contractor can make an effort toward improving the value of the asset, i.e., infrastructure, but the level of effort (or investment) made by the contractor is not observed or contractible by the government.

[3] As will be discussed in the following sections, particularly Section V, this bipolar classification may not be straightforward in practice. For instance, even fixed-price contracts can be ex post modified under certain conditions. In conventional infrastructure concessions, a price adjustment mechanism is stipulated in the contract as a clear formula. But there may remain some ambiguity in applying it, for example when X-inefficiency is taken into account. In other cases, some parts of the contract are fixed while others are ex post adjustable, as in some public contracts in the United Kingdom (see below).

Ownership, which is assumed to be predetermined before the transaction, namely at time 0, would decide how to divide the outcome, which is after all observable for both parties.[4]

Under the above setting, there are two possible regimes to realize this public work: in-house provision and procuring it from the outside. The former option can also be referred to as nationalization, public infrastructure provision and state-owned enterprises. The latter may represent privatization and traditional public procurement from the outside.

It is clear that there is no incentive for the agent to make any efforts to improve the value of infrastructure when the transaction is internalized under the state ownership, because the government who owns the asset will exploit the entire surplus from the project at the end. Therefore, the optimal choice for the contractor is to make no effort. This represents the typical public ownership failure that government officials would not be motivated to improve the quality of public services, thus retaining operational inefficiency. Everywhere is evidence for this (e.g., Megginson *et al*., 1994; Jimenez, 1995; Morrison and Schwartz, 1996; Koski and Majumdar, 2000; Wallstern, 2001, 2002). For example, the public ownership and provision of infrastructure services tends to suffer from much low labor productivity, and therefore, infrastructure PPP almost always bring about labor retrenchment in Latin America (Table 1). Governmental operators are in general considered less able to control operating costs, slower to adopt new technologies and managerial practices, and less responsible to the needs of users (e.g., Besant-Jones, 2006; Andres *et al*., 2008).

Proposition 2. Under the incompleteness of contracts, there is no incentive for public officials to make efforts to improve efficiency in infrastructure provision under the public ownership (and provision).

[4] In both theory and practice, nonetheless, it is still open to argument what ownership means. It may vary from model to model. See, for instance, Hart and Moore (1990), Hart (1995), and Hart *et al.* (1997).

Table 1. Improvement of privatized electricity distribution companies in Latin America

Country	Argentina		Chile	Peru
Company	EDESUR	EDENOR	CHILECTRA	Luz Del Sur
Year privatized	1992	1992	1987	1994
Change in energy sales (%)	79	82	26	19
Change in energy losses (%)	–68	–63	–70	–50
Change in employment (%)	–60	–63	–9	–43
Change in customers per employee (%)	180	215	37	135
Change in net receivables (days)	–38	…	–68	–27
Change in provisions for bad debts (% of sales)	–35	…	–88	–65

Source: Besant-Jones (2006).

On the other hand, if the government chooses to procure the public work from the outside, the level of efforts by the contractor may not be zero but still suboptimal, because the improved outcome will be partly shared by the government. In this case, it is assumed that a bargaining game over the ownership of the asset would take place. While the government is faced with a hold-up problem in the sense that there is no alternative option to procure this project, the contractor may have a positive reservation price of the object being delivered. Given the expected bargaining outcome, the contractor can select the optimal level of efforts, which would turn out less than the optimum.[5]

Proposition 3. In traditional public procurement from the outside, the level of efforts made by contractors is not zero but still remains suboptimal.

The model can be extended to include various elements that are not contractible ex ante and not enforceable by a third party, e.g., courts and regulators. For example, the quality of infrastructure work delivered or services provided may be non-contractible. Hart *et al.* (1997) discuss the cost and quality of services under the public and private provision, specifically questioning when a government should provide public goods in-house, given its imperfect ability to observe the agent's effort toward cost reduction and quality improvement. In their model, a benevolent government, which owns a facility, can either hire a manager, i.e., a

[5] Under the assumption that the agent's cost function of effort (or investment) is convex, it can be shown that the socially optimal level of efforts, which maximizes the benefit from quality improvement by efforts minus agent's cost associated with those efforts, would exceed the level of efforts selected by the agent under the incomplete contract context (Hart, 1995).

government employee, or privatize the facility and let a private contractor to operate it.[6] Thus, ownership and provision are tied together. Of particular note, it is also assumed that the government is concerned about the quality of infrastructure services, which are ex post observable but not contractible ex ante. On the other hand, the manager or contractor does not care directly about quality but can influence the level of quality through its private effort or investment. Under these circumstances, there are two possible actions for the public or private manager: making an effort to improve quality and introducing an innovation to reduce costs at the cost of deteriorated quality. In any case, the agent has to bear the cost associated with efforts to improve quality and contain costs.

Under the private ownership, there is the maximum incentive to invest in cost reduction and quality improvement, because, unlike governmental officials, a private operator does not have to obtain the consent on new innovations from the authorities. However, the privatized operator may invest too much in cost reduction technologies because the deterioration in quality caused by cost reduction measures may not be taken into account. In general, private contracting is cheaper but can threaten quality. The realized quality could be greater or lesser than the optimum.

By contrast, under the state ownership, again, there is little incentive for government employees to contain the public costs and improve the quality of infrastructure services. Underinvestment in both quality improvement and cost reduction would likely happen. The government officials may invest some in quality improvement but not sufficiently. The reason is the same as the above: The manager has to share the gains from increased quality with the government through a bargaining game. In general, when a reduction in supply costs causes only a small deterioration in quality, the private ownership provides the better incentive for quality improvements and cost-cutting. As the downside of quality reduction grows, the in-house provision may become superior, as seen in some recent nationalization episodes. In the unbundled, privatized railway sector, coordination failure may significantly

[6] In this case, ownership means nothing but the right to use the facility.

increase broken rails and safety concerns, as seen in the United Kingdom (Martin, 2002). In a vertically integrated system, possibly under state ownership, track, passenger and freight operations may be coordinated better. A more complex regulatory system is required for safety, coordination of operations, and investment in the vertically separated privatization approach (Kessides, 2004).

Proposition 4. Private ownership provides the maximum incentive for quality improvements and cost-cutting when the latter has a small adverse effect on the former. Public ownership may have the advantage when cost-cutting deteriorates quality significantly.

The efficiency of in-house provision also depends on the strength of the incentives of government employees as well as the importance to the government of generating quality innovations. In Andhra Pradesh, India, the state government unbundled the electricity sector to the generation, transmission and distribution functions. Each segment was designed to take the responsibility for managing its operations as a corporate entity under the state ownership. Tariffs among the segments are periodically reviewed in an independent manner, and the government also launched an intensive collection campaign while strengthening the anticorruption policies in the utilities. Even with the state ownership maintained, the sector performance improved considerably. The system losses declined from 38 percent in 1999 to 26 percent in 2003. The collection rate increased to 98 percent by 2003 (Bhatia and Gulati, 2004). In the case of the Phnom Penh Water Supply Authority, a new internal incentive mechanism based on a performance-based wage system and a customer satisfaction survey improved its financial and operational performance dramatically (Table 2). The enterprise is still state-owned but was transformed to an autonomous, commercially oriented and financially self-sufficient water company (ADB *et al*., 2005).

Proposition 5. Public ownership 'can' have the advantage if quality is considered publicly important and government employees are well incentivized toward cost reduction and quality improvement.

Table 2. Performance of Phnom Penh Water Supply Authority

	1993	2003
Customers	26,881	105,771
Billing rate (%)	28	83
Collection rate (%)	50	101
Unaccounted for water (%)	72	17
Total revenue (Billion riels)	0.7	38.6
Total operating expense (Billion riels)	1.4	10.1

Source: ADB *et al*. (2005).

There are several shortcomings in the above property rights models. First, ownership and provision are designed to be tied together. This may not hold in reality, particularly in the recent infrastructure sector where there are a variety of arrangements for private sector participation. This problem can be addressed by the infrastructure bundling models in the following section. Second, the models do not take into account the government's informational losses from contracting out to the outside (e.g., Schmidt, 1996).[7] Third, it is assumed that there is no rent-seeking lobbyist and self-interested politician or government (e.g., Boyco *et al*., 1996). Fourth, there may be a number of potential contractors that can undertake a public contract in question. The property rights approach does not provide any guidance on how to select the best contractor. This can be answered by auction theory. Finally, since contracts are assumed to be incomplete, it is likely that the original contracts would be adjusted in due course, especially in the context of infrastructure development, which usually takes a considerably long time to accomplish. Some recent models incorporate these ex post contractual adjustments in an explicit manner.

[7] Schmidt (1996) emphasizes the government's informational losses from contracting. The government cares about the social benefit and can acquire a producing firm through nationalization, in which case it can directly control production. If the government already owns the production facility, the government can privatize it. Only managers can observe the unverifiable true production cost before deciding on the level of production. Therefore, if the government privatizes the firm, it loses such important information. The right to have access to inside information about the firm translates into a residual right of control. Under nationalization, however, the manager does not take into account the social benefit and do not make an effort to the optimal level. Hence, the government prefers privatization to nationalization if and only if the social welfare gain through more investment outweighs the negative effect of information losses under privatization.

III. BUNDLING OR UNBUNDLING PUBLIC TASKS?

There are wide variations in how to involve the private sector in infrastructure. In the traditional contract theory, as shown above, the government decision is essentially dichotomous: whether a public work is produced in-house or contracted out to the outsider. And ownership is supposed to go with provision. For instance, in the model by Hart *et al.* (1997), public tasks may be multiple; but they cannot be separated and must be carried out by a single agent, i.e., either employees or a private firm. But infrastructure projects can consist of a number of elements: planning, financing, construction, operation and maintenance, management, service provision, and ownership. Therefore, various types of public private partnership (PPP) are possible (Table 3). For instance, ownership can be retained by governments, while contracting out management (i.e., management contract) or operation and maintenance (i.e., lease or concession). Governments can trade away all the elements to the private sector (i.e., divestiture). Governments can also provide public services using private financing (i.e., nonrecourse private financing).

Table 3. Main features of public-private partnerships

Allocation of responsibilities	Management contract	Lease	Concession	Divestiture
Asset ownership	Public	Public	Public	Private
Operation and maintenance	Private	Private	Private	Private
Capital investment	Public	Public/Private	Private	Private
Commercial risk	Public	Private	Private	Private
Duration	3-5 years	8-15 years	25-30 yeas	Indefinite

Source: Besant-Jones (2006).

Ownership can be separated from investment and operation. Besley and Ghatak (2001) assume that both government and agent care about the quality of public work, showing that the optimal ownership depends on the relative importance of the public and private good components. The critical assumption of Hart *et al.* (1997) is that the only government values quality or social investment in quality, whereas the agent does not value it directly. Conversely, when quality is public goods—i.e., both parties take quality into consideration—the party that attaches a higher value to quality should own the asset. This holds even if it is

not the investor or the provider. Otherwise, the investing party should be the owner, because the alignment of ownership with investment responsibility will allow to internalize externalities and mitigate conflicts of interest.

Proposition 6. If quality is important, the party that attaches the highest value to it should own the facility. Otherwise, the owner should be the investor regardless of whether public or private.

In Estonia, for instance, the major freight operation and track infrastructure were renationalized in 2007, after a 5-year private sector management. The reason is that significant concern arose about safety vis-à-vis investment in rolling stock, as in the United Kingdom. The government signed an agreement to sell 66 percent of the shares of Estonian Railways to an international consortium in April 2001. However, the operator's safety, traffic and financial performance as well as investment in infrastructure were considered unsatisfactory. In this case, it was the government that has put a high value on the primary public objective of the sector, namely public safety.

Hart (2003) examines a choice of whether bundle or unbundle construction and operation tasks, when contracting out both of them. It is assumed that all provision is private. Therefore, the model focuses on comparing PPP (bundling) and conventional infrastructure procurement (unbundling). With ownership retained, the government can contract with a single private entity to build and operate a facility or contract separately with a construction company and an infrastructure operator. The contract specifies the basic characteristics of the facility and the services it provides, but the contract is incomplete so that the builder can modify the investment plan without violating the contract. The problem is that the builder's investment will have an impact on the following operations, as modeled in Hart *et al.* (1997). Some investments are productive, whereas others are not. Investments and their impacts are all assumed unverifiable.

Not surprisingly, when tasks are unbundled, the builder invests as little as possible, because it neither realizes the social benefit (e.g., quality) nor incurs the operating cost. Under the bundling framework or PPP, the concessionaire (i.e., builder and operator) would invest in cost reduction and quality improvement, but it would also invest in unproductive activities, such as quality-deteriorating cost reduction innovations. This is because the concessionaire does care about the cost of operation but may not still take into account the potential social benefit. This provides an analogue to the above Proposition (4), which compares state and private ownership.

Proposition 7. Bundling construction and operation or PPP provides the better incentive for quality improvements and cost-cutting, when the latter has a small adverse effect on the former. The unbundling approach or traditional procurement may have the advantage when cost-cutting deteriorates quality significantly.

Shortcomings in Hart (2003) are that ownership does not play any role and that the length of the contract is assumed given. Bennett and Iossa (2005), incorporating those factors, examine a case with multiple tasks and potentially more than one contractor. In this setting, the government decides how to delegate two different tasks, capital investment and operation of infrastructure, to the private sector. It can either delegate each task to a different contractor or contract out both tasks to a consortium of the two firms. The tasks are assumed to require individual specialized skills. Therefore, any single agent cannot perform both tasks simultaneously. The model also allows the government to retain ownership of the asset and transfer it to the private sector at any time, i.e., during the building and managing phases and even at the end of the contract period. Hence, both parties have individual residual values of the facility. Other major assumptions of the model are maintained following Hart (2003); non-contractible effort at the construction stage could improve social benefit or quality of public work, thereby reducing the operation and maintenance cost at the following stage and increasing the residual value of the project at the end.

There are three possible cases. First, it is predicted that bundling construction and operation would always be optimal if there exist positive externalities between them. This is the setting that the above-mentioned contract theory implicitly assumes. Second, when externalities are negative and weak, contracting out the two tasks to separate entities is more preferable. In these two cases, the bundled or unbundled project can be either contracted out to the private sector (i.e., concessions) or retained by the government (i.e., state-owned enterprises). Under private ownership, concessionaries care about cost reduction and the residual value of the facility, but do not account for social benefits. Under public ownership, contractors can take social benefit into consideration, but only partly. It is because any gain must be shared with the government through a bargaining process. But such adverse effects are assumed fairly small (i.e., externalities are weak). Finally, if the two tasks exhibit strong negative externalities, overinvestment may occur anyway because of the failure of internalization of such negative externalities. It means that the contractor in charge of infrastructure construction tends to overinvest in useless innovations.

Proposition 8. Contracting-out an infrastructure project with construction and operation bundled is always optima, if externalities between those two tasks are positive, the effect of investment on cost cutting and quality improvement is relatively small, the effect of investment on the residual values is large, and if the private residual value is higher than the public residual value.

Bennett and Iossa (2005) also show that if construction and operation exhibit weak negative externalities, the preferable structure would tend toward state ownership as the contract duration of service provision is getting longer. This is because longer contracts would reduce the present value of the residual value of the facility. On the other hand, longer contracts would increase the social benefit from investment, because people could enjoy the benefit over a longer period of time. Accordingly, government ownership is more favored.

Proposition 9. When two public tasks exhibit weak, negative externalities, unbundling is optimal. Moreover, public ownership would be superior to fragmented privatization as the duration of contracts becomes longer.

In the real world, there are wide variations in PPP transactions, but there is a systematic trend reflecting the nature of individual infrastructure sectors (Table 4). The majority of PPP transactions take a form of greenfield projects where private firms or public-private joint ventures build and operate a new facility for the period specified in the project contract. This is a part of concessions in Table 3 and includes build, lease, and transfer (BLT),[8] build, operate, and transfer (BOT),[9] build, own, and operate (BOO),[10] merchant,[11] and rental.[12] Concessions are also a common mode of PPP transactions in particular for transport and electricity utilities. In the telecommunications sector, in which commercial investments are becoming increasingly feasible in recent years, divestiture is also an important tool of private sector involvement. In total, more than 90 percent of PPP transactions concluded between 1990 and 2007 aimed at integrating investment and operation under the greenfield, concession or divestiture framework.

Table 4. Number of PPP transactions between 1990 and 2007

	Energy	Telecom	Transport	Water & sewerage	Total
Management & lease contract	35	5	62	104	206
Greenfield project	971	589	376	226	2162
Concession	103	10	594	241	948
Divestiture	478	203	65	26	772
Total	1587	807	1097	597	4088

Source: PPI database.

[8] A private sponsor builds a new facility largely at its own risk, transfers ownership to the government, leases the facility from the government and operates it at its own risk up to the expiry of the lease.

[9] A private sponsor builds a new facility at its own risk, operates the facility at its own risk, and then transfers the facility to the government at the end of the contract period. The private sponsor may or may not have the ownership of the assets during the contract period.

[10] A private sponsor builds a new facility at its own risk, then owns and operates the facility at its own risk.

[11] A private sponsor builds a new facility in a liberalized market in which the government provides no revenue guarantees. The private developer assumes construction, operating, and market risk for the project.

[12] Electricity utilities or governments rent mobile power plants from private sponsors for periods ranging from 1 year to 15 years. A private sponsor places a new facility at its own risk, owns and operates the facility at its own risk during the contract period.

Of particular note, there are a considerable number of management and lease contracts in the water and sewerage sector. This may reflect the fact that the water sector is especially sensitive to political and social consideration. Water provision also has extensive externalities for public health and environmental issues. In addition, the scope for introducing competition in water and sewerage services is much more limited, because local networks of pipes and sewers remain quintessential natural monopolies. The water and sewerage sector often requires relatively costly building substance in networks, though the cost of producing water is fairly low (Kessides, 2004). These characteristics seem to be consistent with Proposition (9). Externalities may not be so significant between operation and construction. The long period of time is required to recover the upfront investment. Accordingly, it is often required for governments to grant revenue guarantees or operational subsidies.

The unbundling approach may work well in particular in the water and sewerage sector. Despite underlying political, social and financial difficulties, some of the commercial performance can be improved under the relatively short-term management or lease contract framework without any large investment involved. In Yerevan, Armenia, a 4-year management contract was awarded for managing a water and sewage system in 2000. Performance was linked to various targets: electricity consumption, metering, operating hours of service and tariff collection. Electricity consumption was reduced by 30 percent, and collection improved from 20 percent to near 100 percent (World Bank, 2006). Similarly, since the early 1990s, the Czech Republic has gradually involved the private sector in its water and sewerage sector. In České Budějovice, the South Bohemian capital of the republic, a private operator was granted a 12-year lease contract in 1999. The private sector participation lowered unaccounted-for water from 37 percent in 1999 to 24 percent in 2004. A mixed management contract scheme with a public enterprise and a public-private joint venture in Conakry, Guinea improved the metering rate from 5 percent before 1989 (year of water reform) to near 100 percent in 1996. Labor productivity also increased from 20 to 60 connections per employee during the same period (Ménard and Clarke, 2002).

Even though classified as a concession, it may not necessarily involve significant investment. In Colombia, for instance, four major port operations were contracted out to private operators under the concession agreements. But little investment was involved in the initial concessions. Private sector involvement focusing on operational efficiency together with deregulation could increase the port performance remarkably; the number of working days per year increased from 280 days in 1993 to 365 days in 1996 (Table 5). The initial problem was a lack of competition among ports under the national ownership, rather than a shortage of port capacity (Kessides, 2004).

Table 5. Operating performance of ports in Colombia

	Before 1993	1996
Average vessel waiting time (days)	10	0
Working days per year	280	365
Average working hours per day	16	24
Tones per vessel per day		
Bulk cargo	500	>2,500
General cargo	750	1,700
Containers per vessel per hour	16	25

Source: Kessides (2004).

Nonetheless, integrating multiple relevant public tasks into the same ownership is in general an optimal choice, as claimed in Propositions (7) and (8). In the above-mentioned case of Conakry, the water management contract achieved some performance improvements, such as metering and labor productivity. However, other important factors still indicated poor performance, because of the compromised ownership system. Although the majority of a joint venture is owned by a 10-year private lease contractor (51 percent), the government owns 49 percent and is deeply involved in operations. The asset is owned by a state-owned enterprise, which is responsible for large investments in treatment plants, reservoirs and pipes more than 160 mm in diameter. The joint operating company is responsible for only small investments (Ménard and Clarke, 2002). Apparently, the separated ownership seems to have weakened incentives for more aggressive investments in quality improvement and cost cutting. Worse, the sector may remain dominated by the public nature, violating Proposition (4). Unaccounted-for water remained high at 48 percent, compared with the international standards of 10 to 20 percent. Labor productivity jumped immediately

following reform; however, since then it has unchanged at 50 to 60 connections per employee. It was still low compared with other developing countries (normally more than 100 connections per employee).

IV. How to Select Contractors?

Even though it is agreeable what should be produced in-house and procured from the outside, and how, another challenging issue is how to find the most efficient and reputable contractor for a particular contract. In auction theory, there are a number of theoretical propositions. This section provides only a few examples relevant to infrastructure procurement.

The first and most important theoretical prediction in auction theory may be the Revenue Equivalence Theorem. It requires various assumptions, which may not hold all together in reality. The theorem could provide a solid foundation for the government's choice among basic auction platforms. Under the assumptions of (i) singleton and indivisibility of an object, (ii) independent and identical distribution of private values, (iii) bidder symmetry, and (iv) bidders' risk neutrality, all the following auctions generate the same expected payoff: open ascending-bid, open descending-bid, first-price sealed-bid, and second-price sealed bid auctions.

Proposition 10. Under the traditional independent private value paradigm, all four basis auction formats would yield the same expected payoff for governments.

In practice, however, there are many variations in auction design. See, for instance, Wolfstetter (1996) and Klemperer (2002). Bidders may not be symmetric; some are intrinsically strong, and others are not. Bidders' valuations can be affiliated with one another. Bidder entry might be endogenous. It is possible that more than one object is auctioned simultaneously.

Of particular note, there is a general alleged notion that public procurement might be affected by corruption and collusion. Auriol (2006) estimates the cost of corruption to be between 4 and 10 percent of procurement spending. Under the circumstances where an auctioneer can design an award mechanism in the presence of a threat of corruption, it can be shown, unsparingly, that in small markets, sole sourcing would be optimal, whereas for large purchases, competitive bidding is the best choice. The government is assumed to buy a fixed amount of public services from a private firm through a delegate, i.e., public procurement authority. It is also assumed that the procurement authority can meet with one firm to side-contract on its posterior choice of procurement method. Then, there are two forms of corruption. While "capture" occurs when a firm takes the initiative of bribing the government official to obtain an advantage, "extortion" happens when the official demands a bribe from a firm under the threat of excluding it from the procurement process, bribe which is referred to as facilitation payments. Since fighting extortion entails costs and yields no benefit, the optimal delegation scheme does not prevent it. To cope with the effects of capture, on the other hand, public purchasers should receive incentive payments to resist capture, and those payments should increase with the size of the purchase.[13]

One of the important factors in the recent electricity sector reform in Andhra Pradesh, India is that the state government reinforced the anticorruption mechanism within the utilities (Bhatia and Gulati, 2004). A survey of corruption in South Asia conducted by Transparency International indicates that petty corruption is endemic in utilities (Table 6) (Word Bank, 2009). Utility officials may be faced with a lot of opportunities to accept bribes from procurement to linesmen, and the bidding and evaluation process is one of the most controversial and thus potentially corruption-prone areas (Table 7). Moreover, even if procurement is successfully implemented, public utility officials can be a significant deterrent factor of the sector reform, as experienced in India. Without proper incentive and accountability mechanisms, unions of low-level employees may refuse to refuse to materialize important investments, such as meter installation (Gulati and Rao, 2007).

[13] In practical terms, this should be implemented in tandem with improvements in public sector productivity. Otherwise, it would run the risk of the government's losing fiscal discipline.

Proposition 11. In order to mitigate capture of public procuring agencies, the government has to provide incentive payments to procurement officials in proportion to the size of market.

Table 6. Major actors in power sector corruption

	Bangladesh	India	Nepal	Pakistan
Meter readers	26	23	24	36
Billing employee	7	22	22	24
Officers	20	24	13	12
Linesmen	12	37	36	9
Repairmen		5		1
Electricians		7		3
Others				3

In percentage of respondents reporting corruption with each type of actor. Multiple responses were permitted.

Source: Transparency International; cited in World Bank (2009).

Table 7. Nature of complaints about development project procurement, FY2007

	Number of complaints	%
Qualification of other firms	41	11.8
Technical evaluation	39	11.3
Application of evaluation criteria	37	10.7
Disqualification of bids	29	8.4
Contract administration	25	7.2
Allegation of fraud and corruption	22	6.4
Payment	20	5.8
Combined financial and technical rating	14	4.0
Irregularity before bid opening	14	4.0
Own qualification issue	14	4.0
Quality of bidding document	14	4.0
Bid security	11	3.2
Technical specifications	10	2.9
Bid and proposal submission	8	2.3
Eligibility	6	1.7
Short listing	6	1.7
Irregularity in bid evaluation	4	1.2
Performance security	3	0.9
Contract award	2	0.6
Prequalification	2	0.6
Transparency issue	2	0.6
Conflict of interest	1	0.3
Domestic preference	1	0.3
Irregularity in bid opening	1	0.3
Terms of reference	1	0.3
Other	19	5.5
Total	346	100.0

Source: World Bank (2008).

Despite a number of auction models, another auction model that is of particular interest may be McAfee and McMillan (1986) and Fishe and McAfee (1987), in both of which the principal-agent relationship is examined in the auction contract context. Traditional auction

theory implicitly assumes that every aspect of an object to be sold is describable and contractible. Accordingly, it is presumed that the agreed contract is ex post verifiable and enforceable, and that renegotiation and strategic low-balling (overbidding) are outside the scope of an analysis. In practice, nonetheless, quality and other aspects are not always contractible. If a contract involves significant uncertainty and ex post performance is only partially observed, the contract must of necessity have room for ex post adjustments depending on what event is realized.

McAfee and McMillan (1986) model the public contract payment as a linear combination of each bidder's bid price (fixed-payment) and a stochastic term (cost-plus payment), i.e., payment *p* is the sum of the bid amount *b* and a fraction of ex post cost $\alpha * c$. It is shown that under the symmetric equilibrium assumption, neither the fixed-payment nor the cost-plus contract would be optimal when some aspects are not contractible. Rather, the best contractual mechanism might be something between the fixed payment and cost-plus arrangements. Similarly, Fishe and McAfee (1987) also shows that the contract selected will provide the winning firm with the possibility for positive profits either built into the payment function (ex ante) or as a result of cheating (ex post). Therefore, there is a clear trade-off between resolving ex post incentive problems and minimizing costs in the bidding or ex ante phase of contracting.

Proposition 12. The optimal bidding and contract mechanism consists of both fixed payment and cost-plus arrangement, if the government cannot observe ex post performance and bidders are risk-averse. If bidders are risk neutral, the fixed-payment contract is the best for the government.

One practical application is benchmarking of public contracts, both in terms of price and quality, against market comparators. The price or quality agreed in the initial contract is supposed to be reviewed in due course. It is not exactly a linear model, as modeled in McAfee and McMillan (1986). But price or cost is considered to exhibit the cost-plus nature, while quantity still follows the fixed-payment mechanism. In the United Kingdom, half of

public finance initiative (PFI) projects involve benchmarking to assess the value for money (NAO, 2001).[14]

Another may be PPP contracts with some risks transferred back to the public sector. Payments to government may be largely fixed in particular in concessions. In many PPP transactions, however, governments attempt to mitigate some project risks, especially political, regulatory and macroeconomic risks that are difficult for individual firms to avoid, by providing minimum revenue guarantees or subsidies. Governments can offer a long-term take-or-pay contract for bulk supply facilities to incentivize operators to make continuous efforts (see also Proposition 15 below). The minimum traffic or revenue guarantees also have the partially similar effect to cost-plus arrangements in the sense that incentives for contractors are partly compromised. Regardless of (unobserved) efforts, revenue will be guaranteed.

Apart from auction theory, there are at least two alternative methods of awarding public contracts: (i) direct negotiation and (ii) beauty contest. Milgrom (1985) compares auctions with direct negotiation and explains why the former is more popular than the latter. Note that negotiation is essentially characterized by a bargaining game where the government negotiates one-by-one with a series of sellers that make short-lived offers.[15] Among other things, auctions can be the best way to procure even when the government is in a relatively weak bargaining position relative to the potential suppliers and the awarded contract can be resold. To understand why, consider this simple example adapted from Milgrom's work. Consider a buyer in a weak bargaining position vis-à-vis two potential sellers, firms A and B. Firm A can produce the item being bought at the lowest cost. If the government conducts an auction with a ceiling high enough to ensure that both firms participate, it can expect to buy the good from firm A at approximately the same price that firm B would obtain if it were to

[14] Though, the usage of such a mechanism has been limited thus far. Only eight of the 54 public procurement authorities have actually made use of it.

[15] Short-lived offers make it difficult or impossible for the buyer to compare offers. Milgrom (1985) actually focused on a situation in which a seller was dealing with several buyers; the reinterpretation in terms of our context is straightforward.

resell the contract to firm A—even though firm B may be in a much better position than the government to bargain face to face with firm A. An auction allows a weak bargainer (the buyer) to benefit from the abilities of any stronger bargainers that may be present, forcing the player with the lowest cost to bid as if it were bargaining with a stronger player.

Asker and Cantillon (2005) also compare auctions and negotiation to procure a public good for which both price and quality matter. In their scheme, negotiation performs less effectively than a simple scoring auction, in which firms bid on multiple dimensions (here, price and quality) and specified scoring rules reduce those dimensions to a single dimension on which bids are compared. In an empirical study, Estache *et al*. (2004) find that, for transport infrastructure in Latin America, negotiated contracts have performed worse than bidding mechanisms in terms of the percentage of contracts that had to be renegotiated after the award.

Bulow and Klemperer (1996) provide a formal model to examine the marginal effect of additional competition in an auction in comparison with negotiation. It is indicated that competitive bidding is likely to perform better than bilateral negotiation in selecting contractors, of which private costs cannot be observed. It is always more valuable for procurers to have an extra contractor in the auction than obtaining more bargaining power. With few contractors, governments may be able to augment bargaining power against contractors. With more contractors, governments might lose bargaining power but could induce bidders to reveal their true cost parameters through competitive bidding. In many cases, this competition effect would dominate gains from bargaining power.

Proposition 13. Given a certain number of potential contractors, N, an English auction with N+1 *bidders by seeking one more contender is more profitable for governments than any negotiation with N bidders.*

Another alternative to auctions is to hold a beauty contest. The design of the beauty contest involves the determination of the criteria on which to assess bids, and the weights, if any,

assigned to each criterion. The distinguishing feature is that at least one item is scored in a subjective way. Therefore, like auctions, beauty contests involve a comparison of bids; unlike auctions, the award criteria are—at least to some extent—unquantifiable or subjective. Beauty contests are advocated in some circles and have been used in some major sales—among them the sale of the British 2G and the Spanish and Swedish 3G telecom licenses. However, auctions are generally considered preferable to beauty contests. Binmore and Klemperer (2002) argue that in spectrum right auctions, competitive bidding is better at extracting useful information from potential carriers and could achieve an efficient allocation of resources, because the licenses are sold to those who actually attached the highest prices to the objects.

A key challenge of the beauty contest approach is how to weight multiple criteria. Notably, multidimensional auctions have the same problem in practice. It is always controversial how to weight various criteria or multidimensional bids. There is no clear answer to this. The Swedish spectrum right beauty contest clearly shows the difficulty and lack of transparency in evaluating multiple objectives. Somewhat ironically, the reason for the authorities' decision not to use the auction format was exactly their desire to address multiple objectives, such as more investment, broader coverage, faster transmission speeds and further technological development (Andersson *et al*., 2005). The awarding decision is very sensitive to the weight attached to individual factors (Table 8). If all the criteria had been evaluated simultaneously, rather than in the two step approach, the award result could have been different. With reason the government decision was actually contested in court by Reach Out Mobile, Telia, and Telenordia.

Table8. Multiple criteria in Swedish beauty contest for 3G licenses

Bidder name	Swedish government evaluation						
	1st stage			2nd stage			
	Criteria		Decision	Criteria			Decision
	Number of stations	Invest-ment (SEK bil.)		Area coverage (km2)	Population coverage (%)	Roll-out speed	
Broadwave communications Al	4,700	14.7		32,750	81	09/2002	
Europolitan AB	20,000	27.5	Qualified	165,259	100	01/2001	Awarded
HI3G Access AB	20,814	36.9	Qualified	224,724	100	01/2002	Awarded
Mobility4Sweden AB	8,760	15.3		395,520	100	01/2002	
Orange Sweden AB	8,635	19.7	Qualified	364,528	100	08/2001	Awarded
Reach Out Mobile AB	5,238	15.8		259,944	100	04/2001	
Tele 2 AB	10,186	17.7	Qualified	112,666	100	10/2001	Awarded
Telenordia Mobil AB	7,200	14.0	Qualified	181,346	98	01/2002	
Telia AB	4,100	6.8		308,661	100	01/2002	
Tenora networks AB	7,550	11.2		290,038	100	01/2002	

Source: Andersson *et al.* (2005).

V. EX POST ADJUSTMENT OR HARD INCENTIVE CONTRACT?

Infrastructure projects require long-term commitment from owners and operators, regardless of whether public or private. In addition, they are technically complex and politically sensitive. Therefore, the circumstances surrounding the projects are likely to change over time, and it usually comes about that some unforeseen events would emerge almost unavoidably.

Traditional incentive theory involving multidimensional tasks (e.g., cost reduction and quality requirements) tells that if governments can observe some proxies of the quality of public tasks delivered before purchasing, high-powered incentives, such as fixed-payment contracts, can be compatible with quality enhancement efforts (Laffont and Tirole, 1993). This is analogous to general search goods, for which buyers can use the level of sales as a proxy of product quality, even though quality per se is unverifiable prior to purchasing. In the case of experience goods, of which quality can be observed only upon consumption, this is not possible; governments are confronted with difficulties in achieving two conflicting tasks, cost and quality, by a single policy instrument, i.e., the cost-reimbursement rule. When quality is a matter of serious concern, the optimal contract would tend toward low-powered incentives, i.e., ex post cost-plus arrangements.

Output-based aid (OBA) is one application of the above principle. In OBA, unlike traditional approaches, the payments of aid are linked to the delivery of specific services or outputs. Given the pre-agreed specific policy targets, a significant part of the payments of aid, which aim to subsidize the cost of particularly noncommercial development activities, would be disbursed only after those outcomes have been proven accomplished (GPOBA, 2008). In a community water project in Andhra Pradesh, India, for instance, three outputs are set out: (i) installing an ultraviolet filter water purification plants in each of 25 villages, (ii) registering at least 500 households with water subscription fees paid, and (iii) continuing to operate water supply services with customers paying their bills. The official subsidy covers investment, community awareness and running costs. Twenty percent of it is designed to be disbursed to operators once the first target is achieved. Sixty percent will be paid after the second target is met. The rest will be paid after the third output is confirmed (Mandri-Perrott, 2008). Therefore, it still follows a traditional contractual method, but the authorities can infer the quality of outputs from the actual accomplishment and thereby incentivize contractors to make an effort to achieve the better quality of projects. See more examples in Table 9.

Proposition 14. Some of the performance-related proxies can be used to complement high-powered incentive mechanisms particularly if quantity and quality are net complements, even though ex post quality per se is not verifiable.

Table 9. Selected example of output-based aid

Country	Project description	Output target(s)	Verified outputs (as of June, 2008)	Number of beneficiaries
Armenia	Connect 17,000 low-income households to public gas and heating systems	Households with access to heating through individual connections or local boiler systems	2,344	9,517
Colombia	Connect 35,000 families to the natural gas distribution network	Households with gas connections	30,412	182,472
India	Develop safe drinking water systems in rural communities	Villagers with ultraviolet water purification systems	4	12,000
Mongolia	Provide telephony and Internet services to header communities and soum areas	Public access telephone network	1	22,300
		Wireless network for soum	2	
Morocco	Expand water and sanitation connections to 11,300 low-income households in peri-urban and rural areas	Households with water and sanitation connections	1,764	8,820

Source: GPOBA (2008).

Reputation is another instrument for ensuring the unverifiable quality of public tasks in the dynamic context. Even though public contracts may be characterized as an experience good for governments, quality can be governed by the dynamic mechanisms of tracking contractors' past performance. If similar public tasks are put up for public tender repeatedly, contractors may be motivated to make an effort toward better quality and establish a reputation for fear of disqualification in the future public tendering. This is the same mechanism that provides incentives to general firms to keep improving the quality of their products and containing their misbehaviors, even though products are experience goods (i.e., customers cannot know the quality of a product before they actually consume it).

Calzolari and Spagnolo (2009), formally modeling relational procurement, show that governments can reduce the explicit contract duration and repeat open auctions with performance-based bonus payments, if non-contractible quality is not so important. Conversely, if quality is critical, governments prefer to have an open auction, negotiate with a single contractor without incentive payments and keep the relational contract through indefinite times of contract renewal (i.e., relational contracting). This is the optimal and efficient procurement mechanism when there are a limited number of potential contractors in the market. In intermediate cases, governments could use restricted auctions without bonuses among preselected loyal contractors. In general, there is a tradeoff between competition and quality. The larger number of dedicated contractors could reduce public procurement costs because of the increased competition effect. However, it means that the contractors' expected rent would shrink, thereby reducing the equilibrium quality and requiring the optimal contract duration to be shorter.

Proposition 15. With a limited number of potential contractors, the optimal procurement mechanism is open tendering and then relational contracting, if quality is important. Otherwise, open or restricted auctions could be optimal.

There are a number of examples of feedback mechanisms in online auctions that materialize the reputation effect where the quality of items being traded is ex ante unverifiable (Table 10). In the public procurement context, the U.S. government also discloses the list of vendors excluded from federal procurement on the website. Everyone can access to the black list of suppliers and contractors excluded from business with the federal government (Dellarcocas *et al*., 2006).

Table 10. Selected examples of feedback mechanisms in online auctions

Web site	Category	Feedback mechanism
eBay	Online marketplace	Buyer and sellers rate one another following transaction.
Amazon	Online marketplace	Buyer and sellers rate one another following transaction.
Google	Search engine	Search results are ordered based on how many sites contain links that point to them.
Slashdot	Online discussion board	Positing a prioritized list based on the ratings they receive from readers.
Citysearch	Entertainment guide	Users rate restaurants, bars, hotels, etc.
eLance	Professional services marketplace	Contractors rate their subcontractors.
Epinons	Online opinions forum	Users write reviews about products, and others rate usefulness of reviews.

Source: Dellarocas *et al.* (2006).

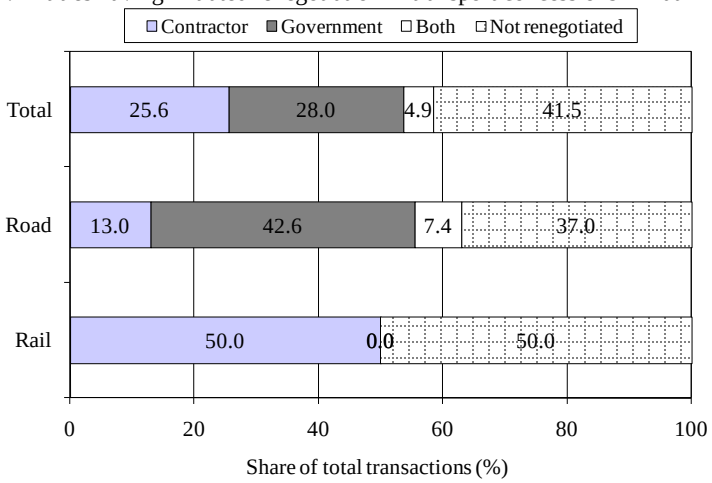
Despite some of these possibilities to mitigate unobservability prior to signing a contract, ex post adjustments may still be unavoidable for some exogenous reasons. Because of contractual incompleteness and because governments can by no means transfer ultimate business risk to private operators (i.e., hold-up problem), bidders would also have a strong incentive to submit unrealistic bids, often referred to as “low balling” and initiate renegotiation afterward (Ware *et al*., 2007). In fact, Guasch (2004) shows that about 30 percent of PPP infrastructure transactions underwent renegotiation within two years after the awards in the Latin American and Caribbean region. In the United Kingdom 55 percent of public finance initiative (PFI) projects experienced some changes in the contracts (NAO, 2001). One may consider the flexibility to ex post adjust a contract as beneficial under highly uncertain environment. However, ex post adjustments are in general considered much costly. Cost overruns and delays in infrastructure projects incur massive economic costs (Flyvbjerg, 2005). Bajari *et al.* (2006) estimates the adaptation cost reflected in the real bids at about 2.7 dollars per one dollar of expected contract adjustment.

Bajari and Tedelis (2001) highlights a clear tradeoff between providing right incentives and reducing ex post renegotiation costs, in favor of adjustable contractual forms when an object being sold is complex. Rigid fixed-price contracts can fully incentivize contractors to contain costs. But if the contract is found incomplete, the adjustment cost could be significant. By contrast, under the more flexible regime, such as cost-plus contracts, adjustments may be less costly, but there is no incentive for cost reduction. The crucial determinant is the cost of ex post adjustments or the complexity of a project being procured. When an object being procured is highly complex, customized and costly to design and specify the details, cost-plus contracts, i.e., ex post adjustable arrangements, will be preferred to hard incentive contracts. This superiority of flexible contracts may be consistent with the reason for public ownership or in-house provision of infrastructure in incentive theory.

Proposition 16. Cost-plus contracts are preferable to fixed-payment contracts when a project is highly complex and the cost of ex ante contract preparation and specification is large.

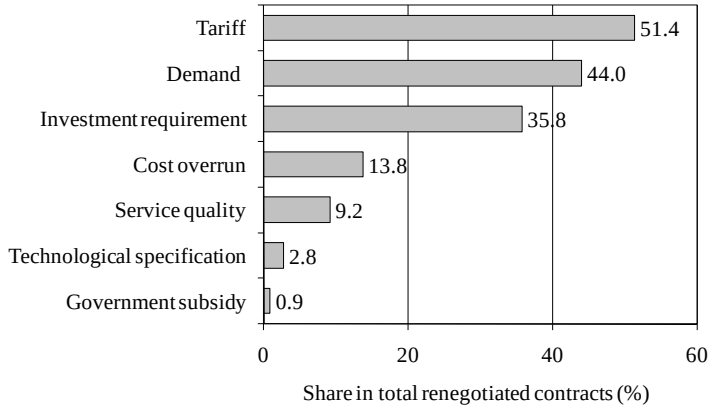
Evidence shows that both governments and private contractors would in fact initiate renegotiation (Figure 2). In 68 road concessions in Latin America, the majority of renegotiation was initiated by the government side, if renegotiated. In the railway sector, out of 28 concessions, half were underwent renegotiation, and all of them were initiated by private operators (Estache *et al*., 2008). In Argentina, most of the concessionaires started disputing with the government, since the government converted the dollar-denominated rates to devalued pesos and refused any significant tariff adjustments, despite the fact that the initial contract clauses allowed for indexation to the dollar. Similarly, the local mayor in Brazil denied the automatic tariff adjustments stipulated in the Limeira water concession (Guasch *et al*., 2007). There are other possible reasons for renegotiation. The fundamental reason is that some revenue and/or cost conditions would change exogenously or endogenously beyond the reasonable assumptions accounted for in the original contracts. Tariff, demand forecasts and investment requirements are the most common three reasons for renegotiation (Figure 3).

Figure 2. Entities having initiated renegotiation in transport concessions in Latin America



Source: Estache *et al.* (2008).

Figure 3. Major reasons for renegotiation in transport concessions in Latin America



Note: The reasons for renegotiation could be multifold; thus percentages may add over 100 percent.

Source: Estache *et al.* (2008).

Even under the assumption that contracts are complete, public ownership may be preferred because of the significant cost of contracting. Levin and Tadelis (2005) shows that if some contingencies are left out of the contract due to costly contracting, an optimal contract for governments would be either to pay the agent for meeting a minimal time requirement or for meeting a contracted performance requirement. But it should not be both. This is because that time and effort are assumed substitutes for the purpose of improving quality. If both time and quality constraints are specified in the same contract, the agent can achieve a given level of

quality at lower costs by substituting effort for time, because time is less costly than effort (by construction). While the minimal time requirement can be understood as in-house provision, the performance requirement represents contracting-out to the outside. Contracting with the private sector requires a costly specification of performance requirements but avoids the low level of employee incentives associated with in-house provision.

Hart (2003) also emphasizes the importance of relative contracting costs. It is concluded that the choice between PPP and conventional provision turns on whether it is easier to write contracts for service provision than for building provision. Traditional public goods provision (unbundling) is appropriate if the quality of upfront investment can be well specified, whereas the quality of subsequent operations cannot be easily contracted. On the other hand, PPP tends to be better if the quality of operations can be set out in the initial contract but the quality of investment cannot be specified. This is the case if good performance measures are available to reward or penalize the service provider, as in relatively short-term management and lease contracts focusing on improving a particular set of commercial factors.

Proposition 17. When contracting with private contractors can be complete but remains costly, the optimal contract is either in-house provision or performance payments. If infrastructure operation is more costly to specify, traditional procurement is better. Rather, if investment is more costly to contract, PPP is better.

One innovative public procurement procedure that could reduce the cost of contracting in public procurement may be competitive dialogue. In 2004, the EU Directive introduced this new bidding process, which is supposed to be used to procure particularly complex objects. Under the competitive dialogue procedure, public procuring authorities take advantage of dialogue with qualified potential contractors to identify the optimal scope of projects. Until the scope is determined, authorities can facilitate implicit competition for an innovative solution and take advantage of information held by private companies (NAO, 2007). This may be characterized as an interim form between beauty contests and traditional auctions and

could reduce the cost of contracting in favor of contracting out infrastructure under high-powered incentives (as following Proposition 16).

VI. CONCLUDING REMARKS

Infrastructure has particular challenges in public procurement, because it is a highly complex and customized object, requiring economic, political, social and environmental considerations from a long time horizon. To deliver public infrastructure services to citizens or taxpayers, there are a series of decisions that governments have to make. This paper characterizes the decisions as a four-stage process: (i) whether to provide in-house or contract out, (ii) whether to bundle or unbundle investment and operation, (iii) how to select contractors, and (iv) whether to contract ex ante or adjust ex post. At each stage, there are important economic theories that could guide governments to wise decision-making.

In general, theory suggests that it would be a good option to contract out infrastructure to the private sector under high-powered incentive mechanisms, such as fixed-price contracts. However, it holds under certain conditions. Key factors include the social benefit from investment, such as quality of public services, and the cost of preparing a contract. If cost-cutting investment has a significant adverse effect on quality, the public ownership can perform better. This may be the case in the public transport sector where the safety of the public cannot be compromised at any cost. This principle may also be applicable to the power generation sector where economic efficiency is not always compatible with environmental and social objectives. Infrastructure development in remote areas is another example.

In addition, the cost of contracting matters a lot. If it is prohibitively high, cost-plus contracts or ex post adjustments would be an appropriate way of procuring infrastructure. It makes little sense to attempt to prepare a complete contract for the long-term infrastructure procurement. It is more important for stakeholders involved to agree on how to deal with

unanticipated events that might happen. In that context, it is worth reiterating that high- and low-powered incentive mechanisms can coexist, as seen in the benchmarking of public contracts and partially-risk guaranteed PPP projects.

Finally, theory tells that ownership should be aligned with the ultimate responsibility for or objective of infrastructure provision. Private ownership can deal with investment in cost reduction to a large extent and quality improvement to a lesser extent. But social benefits might be undermined under private ownership. Public ownership can potentially control social benefits better, but in-house provision is essentially inferior to motivate government officials to make an effort toward better quality and lower costs, though not impossible. If more than one public task exhibits positive externalities, it would be a better option to integrate them into the same ownership.

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